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BEARING CURRENT REDUCTION ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates generally to electric motors and, more particularly, to bearing assemblies for electric motors with adjustable speed drives.

A/C electric motors typically include a motor housing, a stator including one or more stator windings, and a rotor assembly. The rotor assembly includes a rotor core and a rotor shaft extending through the rotor core. The motor housing includes at least one endshield and houses at least a portion of the rotor assembly. Electric motors also typically include at least one bearing sized to receive and support the rotor shaft, and at least one inner bearing cap separated from the bearing. Typically, the bearing is positioned between an endshield and an inner bearing cap and facilitates rotation of the rotor shaft when the stator windings are energized. An adjustable speed drive circuit is coupled to an inverter and the motor to selectively vary the motor speed as desired in a particular application.

Improvements in inverter technology have led to increased use of adjustable speed drives with A/C induction motors. High speed switching of power supplied to these motors often results in charge build up between the rotor and the stator until a sparking voltage develops across the bearing. Once a sparking voltage develops, a spark discharges across the bearing. After the initial spark, a capacitive coupling between the rotor and stator provide a damaging "follow on" current through the bearing. This current damages the bearing thus affecting motor reliability and performance. Insulated bearings, shaft brushes, and modified drive circuits have been employed to reduce and/or eliminate damaging current flow through the bearings, but tend to increase the cost of the motor, reduce motor performance, or introduce costly maintenance issues.

Accordingly, it would be desirable to provide a low cost bearing assembly that reduces or eliminates current flow through the bearings to improve motor reliability and performance while avoiding costly maintenance issues.

BRIEF SUMMARY OF THE INVENTION

In an exemplary embodiment of the invention, a bearing current reduction assembly includes a rotor shaft, an inner bearing cap having an inner end,

and a charge concentrator disposed on either the rotor shaft or the inner end, or both. The inner bearing cap is substantially radially aligned with the rotor shaft. The inner end is in close proximity to the rotor shaft and separated from the rotor shaft by a clearance.

The charge concentrator concentrates electrical charge to produce a higher electrical field concentration through the clearance than occurs within a bearing. Accordingly, during operation of an induction motor with an adjustable speed drive, charge build up between the rotor shaft and a stator discharges at the charge concentrator instead of within a bearing. More specifically, rotor to stator currents through the bearings are reduced or eliminated.

Accordingly, the bearing current reduction assembly provides a low cost bearing assembly that reduces or eliminates current flow through the bearings to improve motor reliability and performance while avoiding costly maintenance issues.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross-sectional view of a motor assembly including a bearing current reduction assembly;

Figure 2 is a schematic view of the bearing current reduction assembly shown in Figure 1; and

Figure 3 is a schematic view of a second embodiment of a bearing current reduction assembly.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 is a cross-sectional view of a motor assembly 10 including a motor housing 12, a stator 14 having a plurality of windings, a rotor assembly 16 and a bearing current reduction assembly 18. Rotor assembly 16 includes a rotor shaft 20 mounted on a rotor core 22. A bearing 24 is positioned between an endshield 26 and an inner bearing cap 28.

Energizing the stator windings with alternating current produces a changing magnetic field or flux within rotor core 22 causing rotor shaft 20 to rotate. The angular velocity of rotor shaft 20 is partially a function of the power delivered to motor assembly 10. Typically, an adjustable speed drive circuit (not shown) is

coupled to an inverter (not shown) and motor assembly 10 to vary an angular velocity of rotor shaft 20. High speed switching of power supplied to motor assembly 10 often produces a charge build up between rotor shaft 20 and stator 14.

Bearing current reduction assembly 18 provides an electrical path from rotor shaft 20 to stator 14 that does not include bearing 24. Accordingly, damaging rotor to stator currents through bearing 24 are reduced or eliminated. Although, an exemplary embodiment is described in the context of a motor having an adjustable speed drive, it is contemplated that the benefits of the invention accrue to a wide variety of motors for various applications and controlled by alternative drive circuits.

Figure 2 is a schematic view of bearing current reduction assembly 18 (shown in Figure 1) including an inner bearing cap 28 substantially radially aligned with rotor shaft 20 and having an outer end 30 and an inner end 32. Inner end 32 includes bearing cap charge concentrator 34 in close proximity with rotor shaft 20 and separated from rotor shaft 20 by a clearance 36. In an exemplary embodiment, clearance 36 is approximately 0.005 inch to provide adequate shaft clearance while facilitating current flow from rotor shaft 20 to stator 14. In an alternative embodiment, clearance 36 is greater or lesser than 0.005 inch. Bearing 24 is positioned between inner bearing cap 28 and endshield 26.

During operation, a charge build up between rotor shaft 20 and stator 14 (as shown in Figure 1) concentrates at bearing cap charge concentrator 34 providing a higher electrical field concentration through clearance 36 than an electrical field concentration through bearing 24. Accordingly, charge build up bleeds off or discharges, flowing through clearance 36 instead of through bearing 24. Thus, damaging current flow through bearing 24 is reduced or eliminated.

In an exemplary embodiment, inner end 32 is machined to provide a sharp edge 38 facing rotor shaft 20 such that sharp edge 38 has a small radius to concentrate charge. Inner bearing cap 28 is fabricated from a suitable electrically conducting material. In an exemplary embodiment, inner bearing cap 28 is made of aluminum alloy 850.00.

Figure 3 is a schematic of another exemplary embodiment of a bearing current reduction assembly 40, similar to bearing current reduction assembly 18, including an inner bearing cap 28 having an outer end 30 and an inner end 32. Rotor shaft 20 includes a rotor charge concentrator 42 in close proximity to bearing cap 28

and separated from bearing cap 28 by a clearance 46. In an exemplary embodiment, clearance 46 is approximately 0.005 inch to provide adequate shaft clearance while facilitating current flow from rotor shaft 20 to stator 14. In an alternative embodiment, the clearance between rotor charge concentrator 42 and inner end 32 is greater or lesser than 0.005 inch. Bearing 24 is positioned between inner bearing cap 28 and endshield 26. In one embodiment, rotor shaft 20 is machined with a sharp edge 44 thereon to provide a rotor charge concentrator 42 with a small radius such that the sharp edge 44 concentrates charge.

During operation, a charge build up between rotor shaft 20 and stator 14 (as shown in Figure 1) concentrates at rotor charge concentrator 42 generating a higher electrical field concentration through clearance 46 than through bearing 24. Accordingly, charge build up bleeds off or discharges, flowing through clearance 46 instead of through bearing 24. Thus, damaging current flow through bearing 24 is reduced or eliminated.

While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.